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DRAFT MEMORANDUM

Date: May 09, 2011

To: Dan McCormack, Boeing

cc: Colette Griffith, Landau

From: Tom Krug, Hester Groenevelt and Suzanne O'Hara - Geosyntec

Subject: Draft Work Plan for Pilot Testing of the Removal and Treatment of Polychlorinated Biphenyls (PCBs) in Paint and Concrete at Boeing Facilities in Washington State

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1. INTRODUCTION AND BACKGROUND

This memorandum has been prepared by Geosyntec Consultants, Inc. (Geosyntec) with input from our academic partners at the University of Central Florida (UCF) to present a draft Work Plan for on-site pilot testing to evaluate the removal and treatment of polychlorinated biphenyl (PCBs) from painted buildings, painted metal structures and concrete (collectively referred to as building materials in this memorandum) at North Boeing Field (NBF). Boeing has identified locations where PCBs are present in concrete expansion joint caulking material; the concrete adjacent to the caulking material may also contain concentrations of PCBs. Boeing has also conducted sampling of paint on buildings and other structures. This sampling has shown that PCBs are present at low concentrations in paint on concrete and metal surfaces of existing buildings. Portions of the pilot test (specifically for concrete treatment testing) may be conducted at Boeing's Everett Facilities in Everett, Washington.

Reduced metal, specifically, zero-valent magnesium (ZVMg), has been shown to be effective in promoting the reductive dechlorination (or degradation) of chlorinated organic compounds including PCBs. Researchers at Geosyntec, the Naval Facility Engineering Service Center (NFESC), National Aeronautics and Space Administration-Kennedy Space Center (NASA-KSC), and UCF recently completed a Department of Defense Environmental Security Technology Certification Program (ESTCP)-funded project (ESTCP Project SI-0610) demonstrating the use of an innovative technology based on the use of ZVMg to remove and degrade PCBs found in building materials and coatings. The results of the demonstration project confirmed earlier laboratory work showing that it is possible to extract PCBs from surfaces of building materials and then degrade the PCBs using an acid-activated ZVMg solvent paste.

The technology uses a solvent paste containing ZVMg to extract PCBs from materials and to degrade the PCBs. The solvent paste is applied to the surface of the material to be treated and

the PCBs are extracted from the material into the paste. The time required for the paste to be in contact with the surface of the material being treated is between one and several days but will vary depending upon the type of material and the depth at which the PCBs are present. As the PCBs are extracted into the paste, they are also degraded by the ZVMg in the paste through a process of reductive dechlorination promoted by the presence of the ZVMg. After the treatment is complete the paste is not considered to be "remediation waste" because the PCBs have been degraded.

It is also possible to treat materials in a two-step process in which a non-reactive treatment paste (not containing ZVMg) is applied to the surface to extract PCBs and then the paste is removed from the surface, placed in a container and ZVMg is added to the paste to degrade the PCBs. The two-step process allows for: 1) the formulation of a non-reactive treatment paste optimized for ease of application and for removal of PCBs from the building material; and 2) more efficient use of the reactivity capabilities of the ZVMg because the ZVMg is added to the paste when the paste contains the maximum concentration of PCBs.

The objective of the pilot testing described in this Work Plan is to evaluate the potential to use the ZVMg paste technology to treat PCBs in: 1) paint on metal and concrete surfaces; and 2) concrete impacted by caulk containing PCBs at NBF.

2. PILOT TESTING SCOPE OF WORK

Pilot testing will be conducted on: 1) painted concrete and metal surfaces; and 2) concrete on the sides of expansion joints that contain or have contained caulking containing PCBs. The test procedures for each of these types of surfaces are described below.

2.1 Treatment of Painted Concrete and Metal

2.1.1 Test Locations

Pilot testing of concrete and metal surfaces with paint containing PCBs will be conducted at two locations in the Propulsion Engineering Lab (PEL) area of NBF:

1. Location 65 - painted concrete wall with 250 ppm PCBs on the northwest side of Building 3-322 (near paint sample 65); and
2. Location 60 - painted metal tanks with 98 ppm PCBs (near paint sample 60); and

These locations were identified based on data collected during the North Lateral Source Evaluation conducted by Landau Associates in 2010 (*North Lateral Storm Drain System Evaluation of Potential Sources Report, North Boeing Field, Seattle, Washington, October 13, 2010*). Figure 1 shows the test locations and the result of analysis of PCBs in paint in areas near the test locations.

To the extent possible, the specific test locations will be selected to be free of paint that is flaking or chipping from the surface of the metal or concrete. One test area will be selected at each location for testing of treatment using a reactive treatment paste and one test area will be selected for testing of non-reactive treatment paste.

2.1.2 Pre-Treatment Sampling

A treatment area measuring 15" by 15" (38 centimeters [cm] by 38 cm) will be defined on each surface to be treated and tested. This area will be divided into 9 squares each measuring 5" by 5" (~13 cm by ~13 cm) as shown in Figure 2. Baseline PCB concentrations of pre-treatment paint samples will be obtained by scraping the paint off the surface from three of the 12 squares. A portion of each of the three samples of paint will analyzed for PCB Aroclors to provide data on the variability of the PCB concentrations in different areas of the painted surface.

Pre-treatment and all other samples of paint will be collected by Geosyntec staff and provided to Landau Associates (Landau) who will arrange for analysis of samples by Analytical Resources, Inc. (ARI).

2.1.3 Application of Treatment Paste

Non-reactive treatment paste will be prepared at the University of Central Florida (UCF) under the supervision of Dr. Cherie Geiger and shipped to NBF. The reactive paste will be prepared at NBF by adding the ZVMg and acetic acid to the non-reactive paste. Geosyntec will apply the treatment paste to an area covering the 15" by 15" treatment area and extending approximately 3 to 4 inches (7.5 cm to 10 cm) beyond the edge of the 12 individual squares for each of the locations to be treated. The treatment paste will be applied using a paint spray gun to produce a treatment layer of approximately ¼" to ½" (0.65 cm to 1.27 cm) thick. The treatment paste layer will then be covered with a spray on sealant consisting of a vinyl polymer to prevent loss of solvent from the treatment paste.

Two different types of treatment paste will be tested, one reactive treatment paste with ZVMg and one non-reactive treatment paste without ZVMg. The components of the paste with ZVMg will be:

1. ethanol - hydrogen donor solvent
2. limonene - paint softener
3. calcium stearate, polyethylene glycol - stabilizers, thickeners
4. sodium polyacrylate - absorbent (delays evaporation)
5. glycerin - thickener
6. acetic acid – maintain low pH and reactivity of the ZVMg
7. ZVMg – reactive material to dechlorinate PCBs

The formulation for the non-reactive paste will be identical except that it will not contain acetic acid and ZVMg. In the tests where non-reactive paste is applied to the painted surface and

treated after removal from the surface ethanol, acetic acid and ZVMg will be added to the non-reactive paste to degrade the PCBs. Attachment A contains a copy of the Material Safety Data Sheet (MSDS) for the treatment paste.

2.1.4 Post-Treatment Sampling

Samples from the treated paint will be collected at approximately 48 hours (2 days) and 120 hours (5 days) after application of the treatment paste. The surface sealant will be cut to isolate two of the squares in each treatment area for collection of samples of paint and treatment paste at each of the two time intervals after application of the paste. After the samples have been collected, the edges of the areas to be sampled during later times will be sealed using a spray on vinyl polymer to prevent loss of solvent from remaining treatment paste.

A portion of each of the two samples of paint collected during each of two sampling events will analyzed for PCB Aroclors.

Portions of the two individual samples of paste recovered at each of the sampling intervals will be analyzed for PCB Aroclors. One composite sample of the sealant from the two sample areas sampled at the final sampling date will also be analyzed for PCB Aroclors.

For tests conducted with non-reactive paste, one composite sample of the paste, termed “raw paste" will be collected from the two sample areas at each sampling time in a suitable container. The raw paste will be treated by the addition of ethanol, acetic acid and ZVMg. After 24 hours, this treated paste will be sampled and analyzed for PCB Aroclors.

2.2 Treatment of Concrete Expansion Joints

2.2.1 Test Locations

Pilot testing of the treatment technology on concrete expansion joints will be performed in an area where caulking removal will be conducted during the 2011 construction season. The exact location for pilot testing on concrete expansion joints will be determined in the field based on aircraft coordination requirements and the caulking removal schedule. Treatment will be conducted on several sections of open concrete joints after the bulk of the caulking has been removed.

Suitable sections of expansion joint will be identified based on accessibility, limited impact on facility operations and known elevated concentration of PCB in caulking materials in the expansion joints prior to removal of the caulking.

The sections of expansion joints will be divided into six approximate 8” (20 cm) lengths for baseline or pre-treatment sampling, treatment with the treatment paste and sampling at different intervals following treatment as shown in Figure 3.

2.2.2 Pre-Treatment Sampling

Prior to conducting testing of the ZVMg paste, it is important to understand the extent of PCB impacts into the concrete. After the caulking material is removed from the expansion joint in the identified areas, two six-inch diameter vertical core samples will be obtained from locations along the identified area to remove the concrete from the surface to a depth of at least 4" (10 cm) below the concrete surface. One sample will provide baseline data for active treatment paste and one will provide baseline data for the non-active treatment paste. Once the core samples are removed, subsamples of concrete will be obtained from different depth intervals into the concrete perpendicular to the surface that was exposed to the caulking material. Two sets of depth discrete samples will be obtained from location approximately 1" (2.5 cm) below the former ground surface of the concrete in each of the two cores. Samples will be collected from both sides of the core sample collected. Samples will be collected from the following depth intervals:

1. surface to 3/8",
2. 3/8" to 3/4";
3. ¾" to 1 and 1/8"; and
4. 1 and 1/8" to 1 and ½".

The diameter of the drill used to collect the samples will be reduced at each depth interval to avoid the potential for cross contamination of the samples, particularly from the shallow depth samples that may contain significantly higher concentrations of PCBs than the deeper intervals.

Only the first two samples of each set of four sample depths will initially be analyzed for PCB Aroclors by ARI. The two deeper samples in each sample set will be termed "optional" samples, and will be archived pending the results of analysis of other samples.

For the purpose of this Work Plan it is assumed that the concrete core samples and depth discrete samples into the concrete core samples will be collected by Landau with Geosyntec present to observe the sampling.

2.2.3 Application of Treatment Paste

Treatment paste will be applied along identified sections of expansion joints in the vicinity of the locations of the baseline sampling. One section will be treated using a reactive treatment paste and the other will be treated with a non-reactive treatment paste.

A seal will be installed vertically at approximately 8" (20 cm) intervals along the joint to define the boundaries between the sections of the joint to be sampled at different times.

Treatment paste will then be applied to the sections of joint to be treated as shown in Figure 4. After the treatment paste has been added to the joint, a surface seal will be applied to prevent evaporation of solvent from the paste. The surface seal will be the same as vinyl polymer used for sealing the painted surfaces.

2.2.4 Post-Treatment Sampling

Samples of the treated concrete will be collected at approximately 48 hours and 120 hours after application of the treatment paste. After the prescribed period of time, the treatment paste will be removed from the section of joint to be sampled using a combination of a small spatula and a vacuum removal and collection system. The surface seal will be removed from the surface and paste will be scraped off the sealant. Treatment paste will be removed from the joint using a small spatula and collected in the vacuum flask that will be part of the vacuum removal and collection system. The remaining paste from the individual sections of the joint being sampled will be removed from the joint using vacuum removal system consisting of a vacuum tube connected to a two-liter vacuum flask connected to a shop vacuum. Water with a surfactant may be used to flush remaining paste from the sides of the joint and allow the remaining paste to be collected in the vacuum flask.

After the paste has been removed from a particular section of the joint, the section will be cored and samples of concrete will be obtained following the same procedures as was used to collect the baseline concrete samples. One core sample will be collected at each time interval for each of the reactive and non-reactive paste treatment areas. Two separate sets of depth discrete samples will be collected from each core. For the 48 and 120 hour sampling events, as for the baseline sampling, only the first two samples of each set of four samples will initially be analyzed for PCB Aroclors by ARI. The two deeper samples in each sample set will be termed "optional" samples, and will be archived pending the results of other analysis.

A portion of the individual samples of paste recovered at each of the sampling times will be analyzed for PCB Aroclors.

Because the surface area of the sealant in contact with the paste is small, the sealant from the top of the joint will not be sampled for PCB analysis but this material will be retained and archived for possible analysis if the results of analysis of the sealant from the paint testing shows that significant concentrations of PCBs may be present in the sealant material.

For tests conducted with non-reactive paste, samples of raw paste from each sampling time not used for analysis of PCB Aroclors will be collected in a suitable container and treated by the addition of ethanol, acetic acid and ZVMg. Following a period of 24 hours, this treated paste will be sampled and analyzed for PCB Aroclors.

3. DATA ANALYSIS

The result of the pilot testing including observations made during treatment and sampling, the results of chemical analysis and an assessment of the implications of the results will be presented in a technical memorandum. The analysis of the data will include a comparison of the treatment levels achieved using the treatment paste with the treatment objectives. The technical memorandum will also include an estimate of the costs to treat each of the three different types

of material (painted metal, painted concrete and concrete impacted by caulking) using the treatment paste technology.

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Table 1: Summary of Analysis for Pilot Testing of PCB Impacted Paint
Table 2: Summary of Analysis for Pilot Testing of PCB Impacted Concrete
Figure 1: Paint Pilot Study Locations
Figure 2: Layout of Treatment Areas for Painted Surfaces
Figure 3: Concrete Joint Sampling Locations
Figure 4: Schematic of Treatment of Concrete Joints

Table 1: Summary of Analysis for Pilot Testing of PCB Impacted Paint
Boeing North Field, Seattle, Washington

	Baseline	2 Day	5 Day	Total Aroclor Analysis
Reactive Treatment Paste				
Location 65 - Reactive				
Paint	3	2	2	7
Paste	0	2	2	4
Sealant	0	0	1	1
Location 60 - Reactive				
Paint	3	2	2	7
Paste	0	2	2	4
Sealant	0	0	1	1
Total				24

	Baseline	2 Day	5 Day	Total Aroclor
Non-Reactive Treatment Paste				
Location 65 - Non-Reactive				
Paint	3	2	2	7
Raw Paste	0	2	2	4
Treated Paste	0	1	1	2
Sealant	0	0	1	1
Location 60 - Non-Reactive				
Paint	3	2	2	7
Raw Paste	0	2	2	4
Treated Paste	0	1	1	2
Sealant	0	0	1	1
Total				28

Table 2: Summary of Analysis for Pilot Testing of PCB Impacted Concrete
Boeing North Field, Seattle, Washington

	Baseline	2 Day	5 Day	Total Aroclor Analysis
Concrete - Reactive				
Concrete				
Aroclor (1st round)	4	4	4	12
Aroclor (optional)	4	4	4	12
Paste				
Aroclor	0	1	1	2
Concrete - Non-Reactive				
Concrete				
Aroclor (1st round)	4	4	4	12
Aroclor (optional)	4	4	4	12
Raw Paste				
Aroclor	0	1	1	2
Treated Paste				
Aroclor	0	1	1	2
Total (1st round)				30
Total (Optional)				24

Y:\Projects\025082\MapDocs\PaintPilotStudy.mxd 5/6/2011 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- North Lateral
- Catch Basin
- Inlet
- Manhole
- Drain
- Drain Sump
- Sump

0 50 100

Scale in Feet

Data Source: SAIC

Note

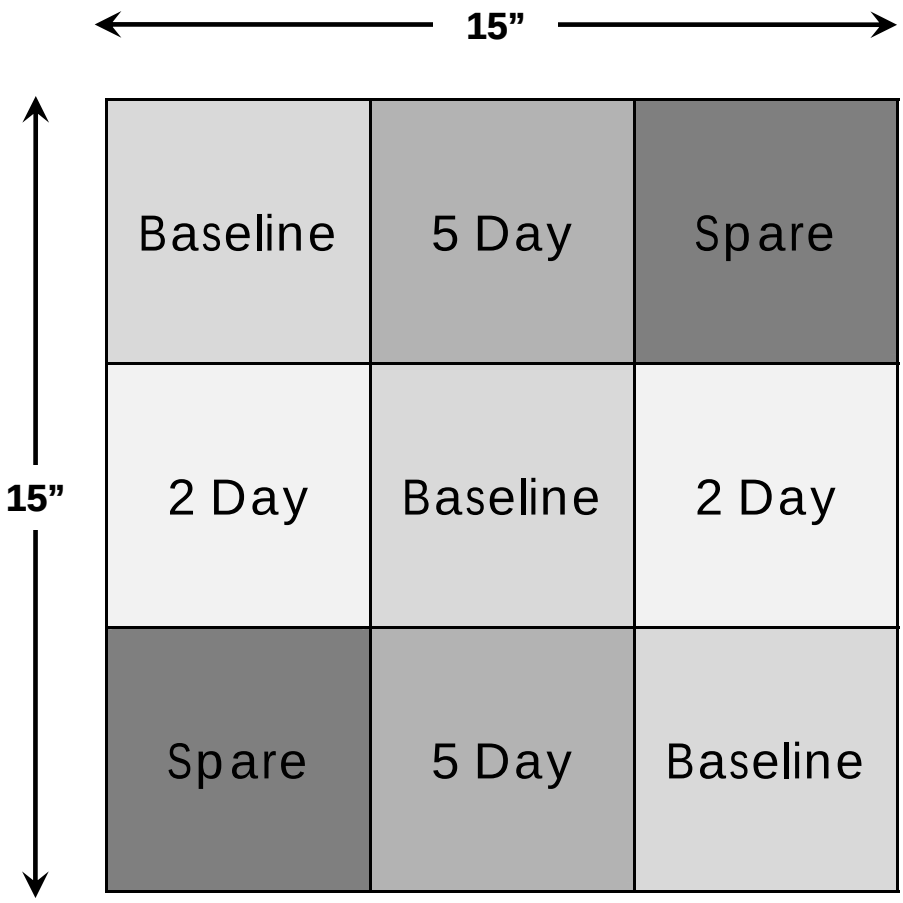
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

North Boeing Field
Seattle, Washington

Paint Pilot Study Locations

Figure
1



Layout of Treatment Areas for Painted Surfaces
North Boeing Field PCB Treatment Pilot Test

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Figure **2**

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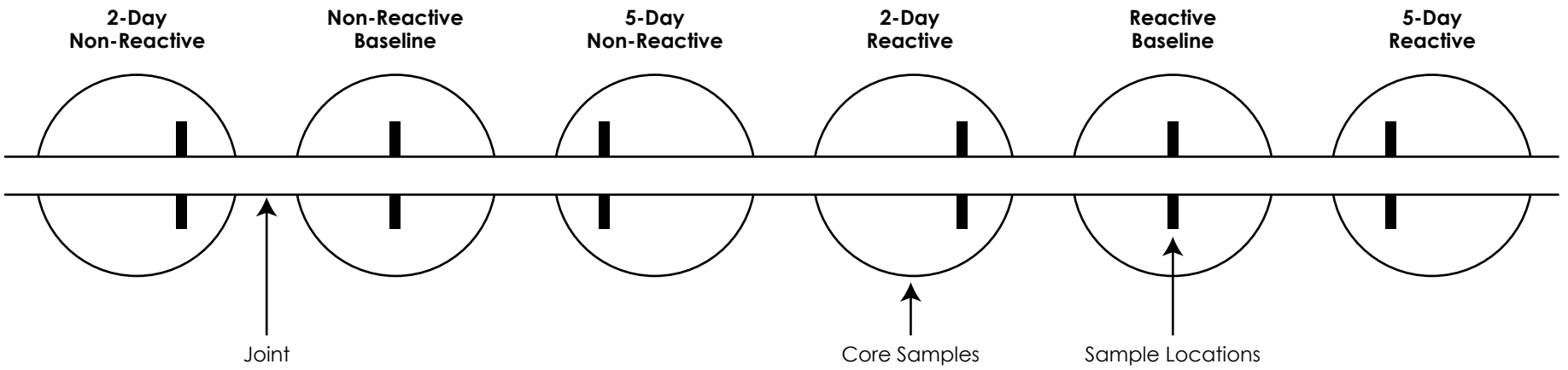
Layout of Treatment Areas.ppt



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Concrete Joint Sampling Locations
North Boeing Field PCB Treatment Pilot Test

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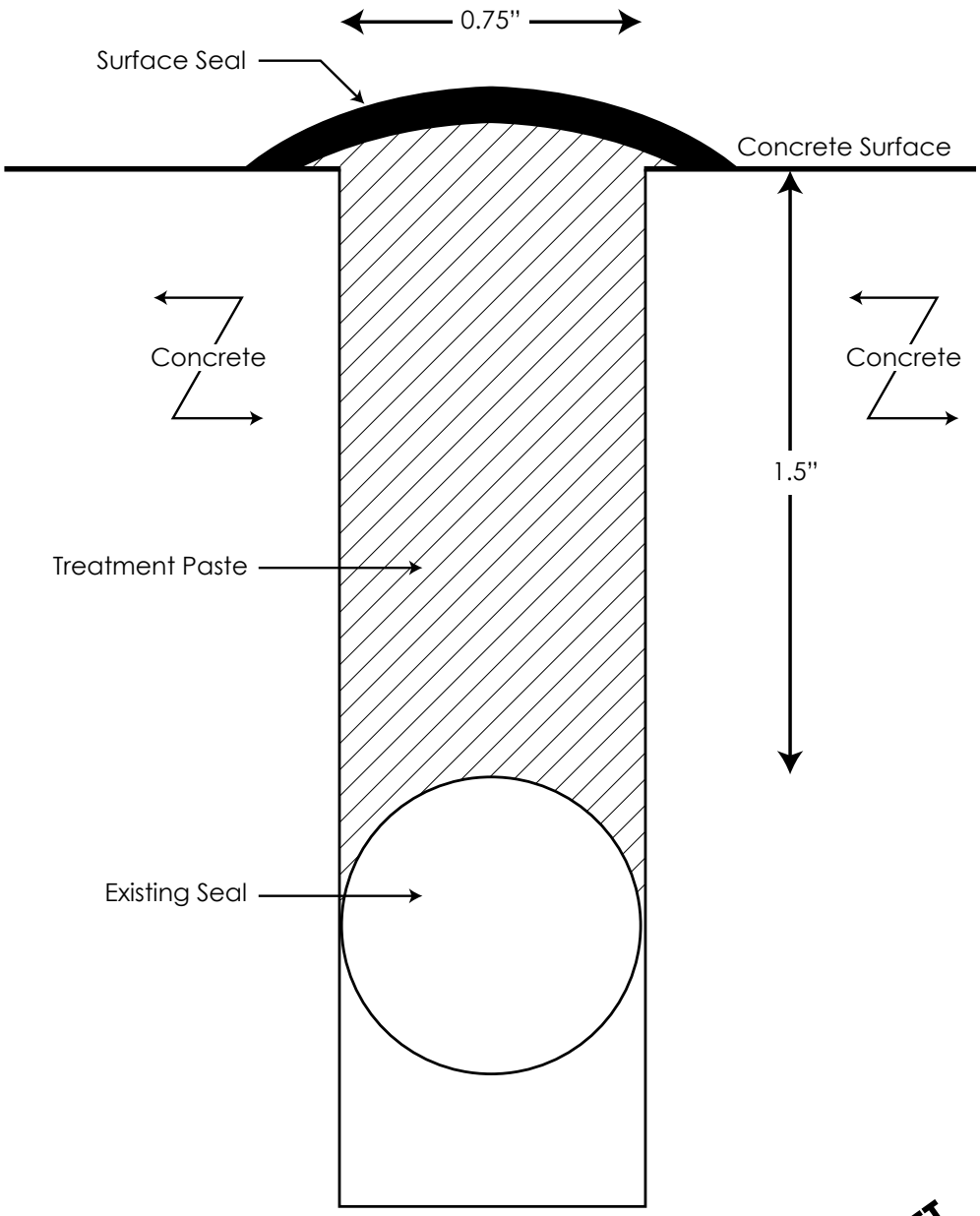
Figure **3**

Concrete Joint Sampling Locations.ai



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Schematic of Treatment of Concrete Joints
North Boeing Field PCB Treatment Pilot Test

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Figure **4**

Schematic of Treatment of Concrete Joints.ai